

MAX336/MAX337

16-Channel/Dual 8-Channel, Low-Leakage, CMOS Analog Multiplexers

General Description

The MAX336/MAX337 are monolithic, CMOS analog multiplexers (muxes). The 16-channel MAX336 is designed to connect one of 16 inputs to a common output by control of a 4-bit binary address. The dual, 8-channel MAX337 is designed to connect one of eight inputs to a common output by control of a 3-bit binary address. Both devices can be used as either a mux or a demux. On-resistance is 400Ω (max), and the devices conduct current equally well in both directions.

These muxes feature extremely low off leakages (less than 20pA at +25°C) and on-channel leakages (less than 50pA at +25°C). The new design offers guaranteed low charge injection (3.5pC, typ) and electrostatic discharge (ESD) protection greater than 2000V, per method 3015.7. These improved muxes are pin-compatible upgrades for the industry-standard DG506 and DG507.

The MAX336/MAX337 operate from a single +4.5V to +30V supply or from dual ±4.5V to ±20V supplies. All control inputs (whether address or enable) are TTL compatible (0.8V to 2.4V) over the full specified temperature range and over the ±4.5V to ±18V supply range.

Applications

- Precision Data Acquisition
- Precision Signal Routing
- Test Equipment

Benefits and Features

- < 400Ω (max) On-Resistance
- < 500ns Transition Time
- < 10Ω On-Resistance Match
- < 20pA NO-Off Leakage Current at +25°C
- 3.5pC Charge Injection
- +4.5V to +30V Single Supply
±4.5V to ±20V Dual Supplies
- Plug-In Upgrade for Industry-Standard DG506/DG507
- Bidirectional Rail-to-Rail® Signal Handling
- TTL/CMOS-Logic Compatible
- > 2000V ESD Protection, per Method 3015.7

Ordering Information

| PART | TEMP-RANGE | PIN-PACKAGE |
|------------|--------------|----------------|
| MAX336CPI+ | 0°C to +70°C | 28 Plastic DIP |
| MAX336CWI+ | 0°C to +70°C | 28 Wide SO |
| MAX336CAI+ | 0°C to +70°C | 28 SSOP |
| MAX336C/D | 0°C to +70°C | Dice* |

Ordering Information appears at end of data sheet.

** Contact factory for dice specifications.*

+Denotes lead(Pb)-free/RoHS-compliant package.

Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW

MAX336

DIP/SO/SSOP/TSSOP
N.C. = NO INTERNAL CONNECTION

MAX336 16-CHANNEL SINGLE-ENDED MULTIPLEXER

| MAX336 | | | | | |
|--------|----|----|----|----|-----------|
| A3 | A2 | A1 | A0 | EN | ON SWITCH |
| X | X | X | X | 0 | NONE |
| 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 1 | 1 | 2 |
| 0 | 0 | 1 | 0 | 1 | 3 |
| 0 | 0 | 1 | 1 | 1 | 4 |
| 0 | 1 | 0 | 0 | 1 | 5 |
| 0 | 1 | 0 | 1 | 1 | 6 |
| 0 | 1 | 1 | 0 | 1 | 7 |
| 0 | 1 | 1 | 1 | 1 | 8 |
| 1 | 0 | 0 | 0 | 1 | 9 |
| 1 | 0 | 0 | 1 | 1 | 10 |
| 1 | 0 | 1 | 0 | 1 | 11 |
| 1 | 0 | 1 | 1 | 1 | 12 |
| 1 | 1 | 0 | 0 | 1 | 13 |
| 1 | 1 | 0 | 1 | 1 | 14 |
| 1 | 1 | 1 | 0 | 1 | 15 |
| 1 | 1 | 1 | 1 | 1 | 16 |

LOGIC "0" = V_{AL} ≤ 0.8V, LOGIC "1" = V_{AH} ≥ 2.4V

Continued at end of data sheet.

Rail-to-Rail is a registered trademark of Nippon Motorola Ltd.



Absolute Maximum Ratings

| | | |
|--|----------------------------|---|
| Voltage Referenced to V- | | TSSOP (derate 12.80mW/°C above +70°C).....1025.60mW |
| V+..... | -0.3V, 44V | Wide SO (derate 12.50mW/°C above +70°C).....1.00W |
| GND..... | -0.3V, 25V | SSOP (derate 9.10mW/°C above +70°C).....727.3mW |
| Digital Inputs, A_, EN_, NO, COM | | CERDIP (derate 16.67mW/°C above +70°C).....1.33W |
| (Note 1)..... | (V- - 0.3V) to (V+ + 0.3V) | Operating Temperature Ranges |
| or 30mA (whichever occurs first) | | MAX336C_I/MAX337C_I.....0°C to +70°C |
| Continuous Current (any terminal)..... | 30mA | MAX336E_I/MAX337E_I.....-40°C to +85°C |
| Peak Current, NO or COM | | MAX336MJI/MAX337MJI.....-55°C to +125°C |
| (pulsed at 1ms, 10% duty cycle max)..... | 100mA | Storage Temperature Range.....-65°C to +150°C |
| Continuous Power Dissipation (T _A = +70 °C) | | Lead Temperature (soldering, 10sec)+300°C |
| Plastic DIP (derate 14.29mW/°C above +70°C)..... | 1.14W | Soldering Temperature (reflow)..... +260°C |
| Plastic DIP (derate 14.30,W/°C above +70°C)..... | 1142.90mW | |

Note 1: Signals on any terminal exceeding V+ or V- are clamped by internal diodes. Limit forward current to maximum current rating.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics—Dual Supplies

(V+ = +15V, V- = -15V, GND = 0V, V_{AH} = +2.4V, V_{AL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP (Note 2) | MAX | UNITS | |
|---|------------------------------------|--|---|---|-----------------|-------|-------|------|
| SWITCH | | | | | | | | |
| Analog Signal Range | V _{NO} , V _{COM} | (Note 3) | | -15 | | 15 | V | |
| On-Resistance | R _{ON} | I _{NO} = 0.2mA, V _{COM} = ±10V | T _A = +25 °C | | 220 | 400 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | | 500 | | |
| On-Resistance Matching Between Channels | ΔR _{ON} | I _{NO} = 0.2mA, V _{COM} = ±10V (Note 4) | T _A = +25 °C | | 5 | 10 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | | 15 | | |
| NO-Off Leakage Current (Note 5) | I _{NO(OFF)} | V _{COM} = ±10V, V _{NO} = ±10V, V _{EN} = 0V | T _A = +25 °C | | -0.02 | 0.001 | nA | |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | | -1.25 | | 1.25 |
| | | | | M | | -20 | | 20 |
| COM-Off Leakage Current (Note 5) | I _{COM(OFF)} | V _{NO} = ±10V, V _{COM} = ±10V, V _{EN} = 0V | MAX336 | T _A = +25 °C | | -0.05 | 0.05 | nA |
| | | | | T _A = T _{MIN} to T _{MAX} | C, E | | -6.5 | |
| | | | M | | | -80 | 80 | |
| | | MAX337 | T _A = +25 °C | | -0.05 | 0.05 | | |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | | -3.25 | 3.25 | |
| | | | | M | | -40 | 40 | |
| COM-On Leakage Current (Note 5) | I _{COM(ON)} | V _{COM} = ±10V, V _{NO} = ±10V, sequence each switch on | MAX336 | T _A = +25 °C | | -0.05 | 0.05 | nA |
| | | | | T _A = T _{MIN} to T _{MAX} | C, E | | -6.5 | |
| | | | M | | | -80 | 80 | |
| | | MAX337 | T _A = +25 °C | | -0.05 | 0.05 | | |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | | -3.25 | 3.25 | |
| | | | | M | | -40 | 40 | |

Electrical Characteristics—Dual Supplies (continued)

(V+ = +15V, V- = -15V, GND = 0V, V_{AH} = +2.4V, V_{AL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP (Note 2) | MAX | UNITS | |
|---------------------------------------|-----------------------|---|---|-----------------|------|-------|----|
| INPUT | | | | | | | |
| Input Current with Input Voltage High | I _{AH} | V _A = 2.4V or 15V | -1.0 | 0.001 | 1.0 | μA | |
| Input Current with Input Voltage Low | I _{AL} | V _{EN} = 0V or 2.4V, V _A = 0V | -1.0 | | 1.0 | μA | |
| SUPPLY | | | | | | | |
| Power-Supply Range | | | ±4.5 | | ±20 | V | |
| Positive Supply Current | I+ | V _{EN} = V _A = 0V | T _A = +25°C | -1 | 0.01 | 1 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -10 | | 10 | |
| | | V _{EN} = 2.4V, V _{A(ALL)} = 2.4V | T _A = +25°C | | 400 | 700 | |
| | | | T _A = T _{MIN} to T _{MAX} | | | 1100 | |
| Negative Supply Current | I- | V _{EN} = 0V or 2.4V; V _{A(ALL)} = 0V, 2.4V, or 5V | T _A = +25°C | -1 | | 1 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -10 | | 10 | |
| DYNAMIC | | | | | | | |
| Transition Time | t _{TRANS} | Figure 2, T _A = +25°C | | 200 | 500 | ns | |
| Break-Before-Make Interval | t _{OPEN} | Figure 4, T _A = +25°C | 10 | 50 | | ns | |
| Enable Turn-On Time | t _{ON(EN)} | Figure 3 | T _A = +25°C | | 250 | 500 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | 750 | |
| Enable Turn-Off Time | t _{OFF(EN)} | Figure 3 | T _A = +25°C | | 100 | 500 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | 750 | |
| Charge Injection (Note 3) | Q | C _L = 100pF, V _{NO} = 0V, R _S = 0Ω, Figure 6, T _A = +25°C | | 3.5 | 10 | pC | |
| Off Isolation (Note 6) | V _{ISO} | V _{EN} = 0V, R _L = 1kΩ, f = 100kHz, T _A = +25°C | | -82 | | dB | |
| Crosstalk Between Channels | V _{CT} | V _{EN} = 2.4V, f = 100kHz, V _{GEN} = 1Vp-p, R _L = 1kΩ, Figure 7, T _A = +25°C | | -86 | | dB | |
| Logic Input Capacitance | C _{IN} | f = 1MHz, T _A = +25°C | | 2 | | pF | |
| NO-Off Capacitance | C _{NO(OFF)} | f = 1MHz, V _{EN} = V _{NO} = 0V, Figure 8, T _A = +25°C | | 2 | | pF | |
| COM-Off Capacitance | C _{COM(OFF)} | f = 1MHz, V _{EN} = 0.8V, V _{COM} = 0V, Figure 8, T _A = +25°C | MAX336 | | 20 | pF | |
| | | | MAX337 | | 10 | | |
| COM-On Capacitance | C _{COM(ON)} | f = 1MHz, V _{EN} = 2.4V, V _{COM} = 0V, Figure 8, T _A = +25°C | MAX336 | | 22 | pF | |
| | | | MAX337 | | 12 | | |

Electrical Characteristics—Single Supply

(V+ = +12V, V- = 0V, GND = 0V, V_{AH} = +2.4V, V_{AL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP (Note 2) | MAX | UNITS |
|-------------------------------|------------------------------------|---|-----|-----------------|-----|-------|
| SWITCH | | | | | | |
| Analog Signal Range | V _{NO} , V _{COM} | (Note 3) | 0 | | 12 | V |
| On-Resistance | R _{ON} | I _{NO} = 0.2mA, V _{COM} = 3V or 10V, T _A = +25°C | | 460 | 700 | Ω |
| DYNAMIC | | | | | | |
| Transition Time (Note 3) | t _{TRANS} | V _{NO-} = ±5V, V _{IN} = 2.4V, Figure 1, T _A = +25°C | | 350 | 600 | ns |
| Enable Turn-On Time (Note 3) | t _{ON(EN)} | V _{INH} = 2.4V, V _{INL} = 0V, V _{NO1} = 5V, Figure 3, T _A = +25°C | | 350 | 600 | ns |
| Enable Turn-Off Time (Note 3) | t _{OFF(EN)} | V _{INH} = 2.4V, V _{INL} = 0V, V _{NO1} = 5V, Figure 3, T _A = +25°C | | 110 | 500 | ns |
| Charge Injection (Note 3) | Q | C _L = 100pF, V _{NO} = 0V, R _S = 0Ω, T _A = +25°C | | 5.0 | 10 | pC |

Note 2: The algebraic convention where the most negative value is a minimum and the most positive value a maximum is used in this data sheet.

Note 3: Guaranteed by design.

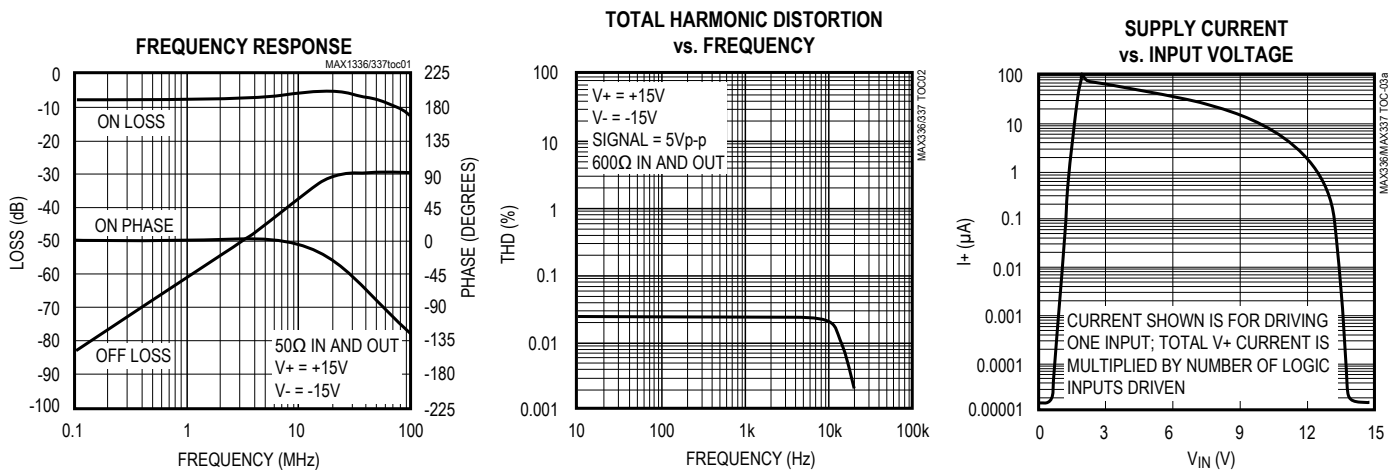
Note 4: ΔR_{ON} = R_{ON}(MAX) - R_{ON}(MIN).

Note 5: Leakage parameters are 100% tested at the maximum rated hot temperature and guaranteed by correlation at T_A = +25°C.

Note 6: Worst-case isolation is on channel 4 because of its proximity to the drain pin. Off isolation = 20log V_{COM}/V_{NO}, where V_{COM} = output and V_{NO} = input to off switch.

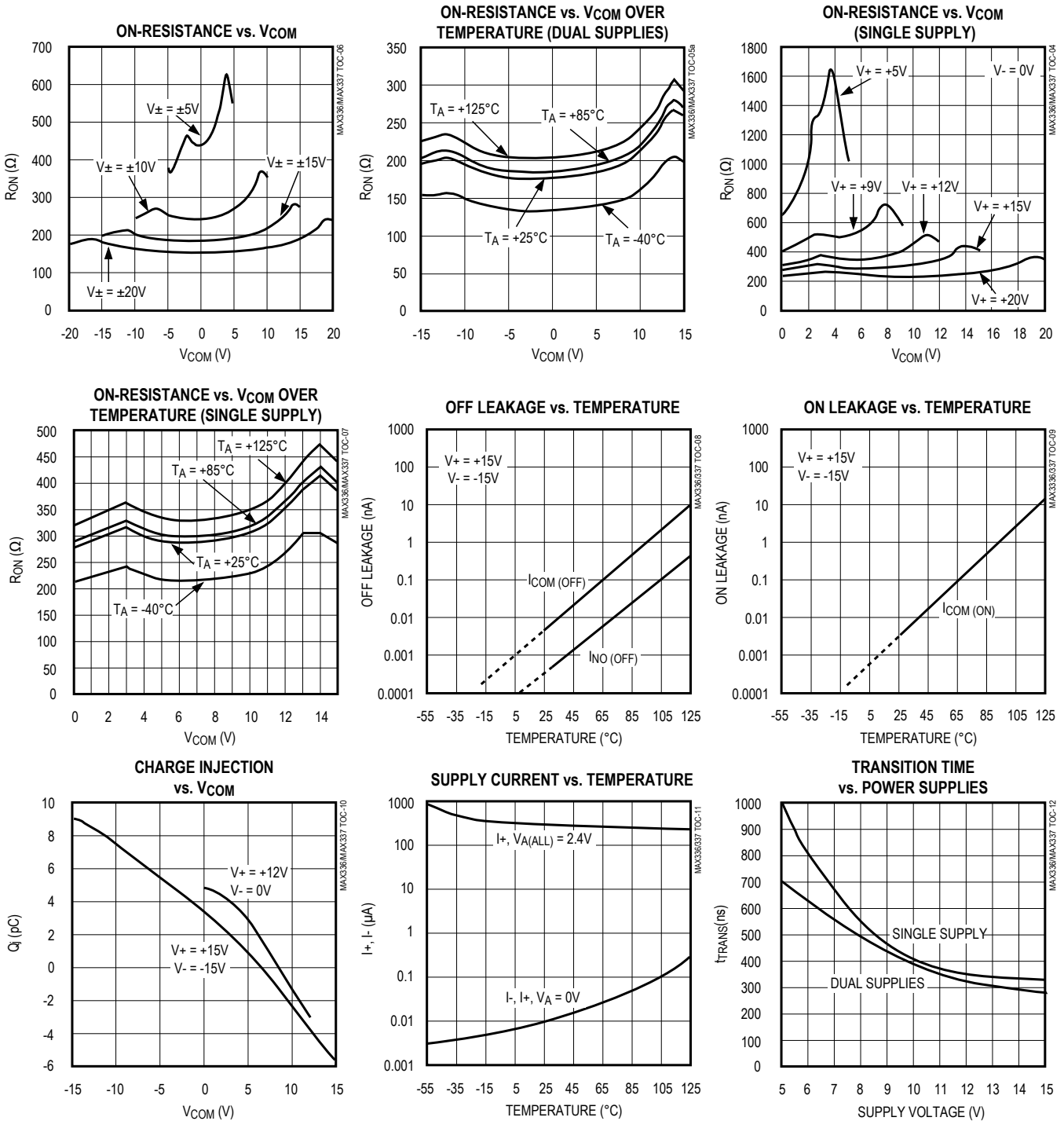
Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted.)



Typical Operating Characteristics (continued)

($T_A = +25^\circ\text{C}$, unless otherwise noted.)



Pin Description

| PIN | | NAME | FUNCTION |
|----------|------------|------------|--|
| MAX336 | MAX337 | | |
| 1 | 1 | V+ | Positive Supply-Voltage Input |
| 2, 3, 13 | 3, 13, 14 | N.C. | No Internal Connection |
| — | 2 | COMB | Analog Signal B Output* (bidirectional) |
| 4–11 | — | NO16–NO9 | Analog Signal Inputs* (bidirectional) |
| — | 4–11 | NO8B–NO1B | Analog Signal B Inputs* (bidirectional) |
| 12 | 12 | GND | Logic Ground |
| 14–17 | — | A3–A0 | Logic Address Inputs |
| — | 15, 16, 17 | A2, A1, A0 | Logic Address Inputs |
| 18 | 18 | EN | Logic Enable Input |
| 19–26 | — | NO1–NO8 | Analog Signal Inputs* (bidirectional) |
| — | 19–26 | NO1A–NO8A | Analog Signal A Inputs* (bidirectional) |
| 27 | 27 | V- | Negative Supply-Voltage Input. Connect to GND for single-supply operation. |
| 28 | — | COM | Analog Signal Output* (bidirectional) |
| — | 28 | COMA | Analog Signal A Output* (bidirectional) |

* Analog signal inputs and outputs are names of convenience only; they are identical and interchangeable.

Applications Information

Operation with Supply Voltages Other than 15V

Using supply voltages less than ±15V will reduce the analog signal range. The MAX336/MAX337 switches operate with ±4.5V to ±20V bipolar supplies or with a +4.5V to +30V single supply. Connect V- to GND when operating with a single supply. Both device types can also operate with unbalanced supplies such as +24V and -5V. The [Typical Operating Characteristics](#) graphs show typical on-resistance with 20V, 15V, 10V, and 5V supplies. (Switching times increase by a factor of two or more for operation at 5V.)

Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings, because stresses beyond the listed ratings may cause permanent damage to the devices. Always sequence V+ on first, then V-, followed by the logic inputs NO and COM. If power-supply sequencing is not possible, add two small signal diodes in series with supply pins for overvoltage protection ([Figure 1](#)). Adding diodes reduces the analog signal range to 1V below V+

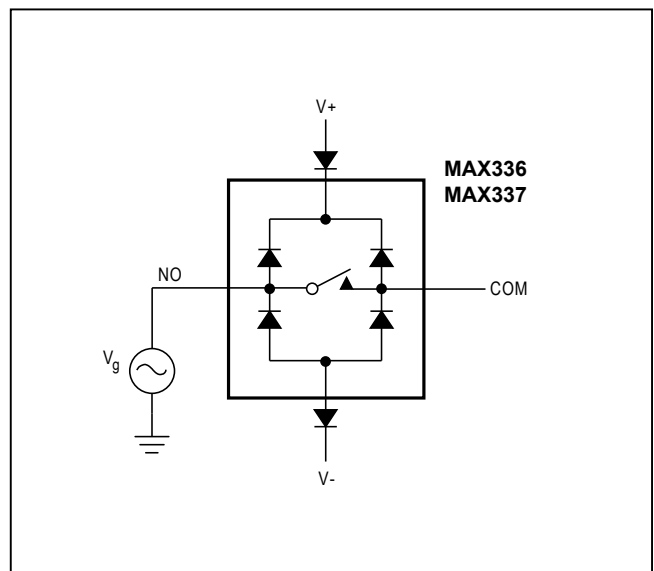


Figure 1. Overvoltage Protection Using External Blocking Diodes

and 1V above V-, but does not significantly affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and V- should not exceed 44V.

Test Circuits/Timing Diagrams

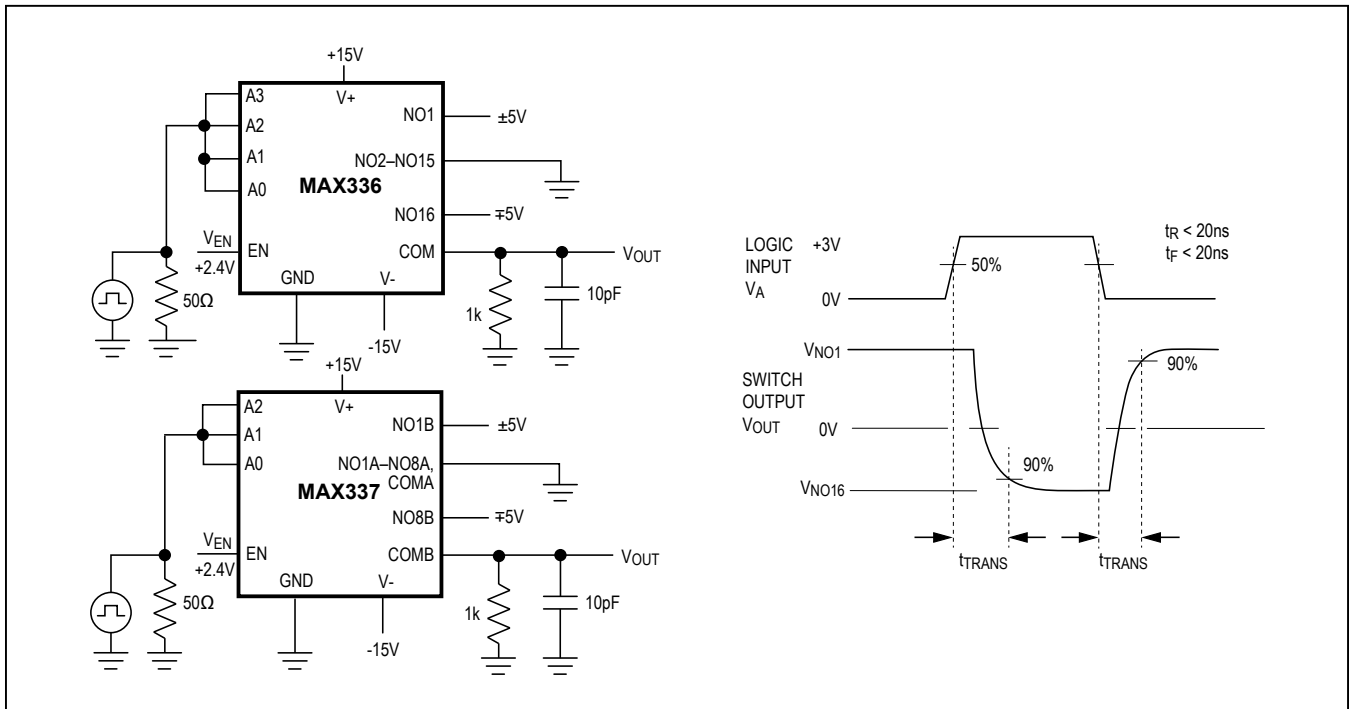


Figure 2. Transition Time

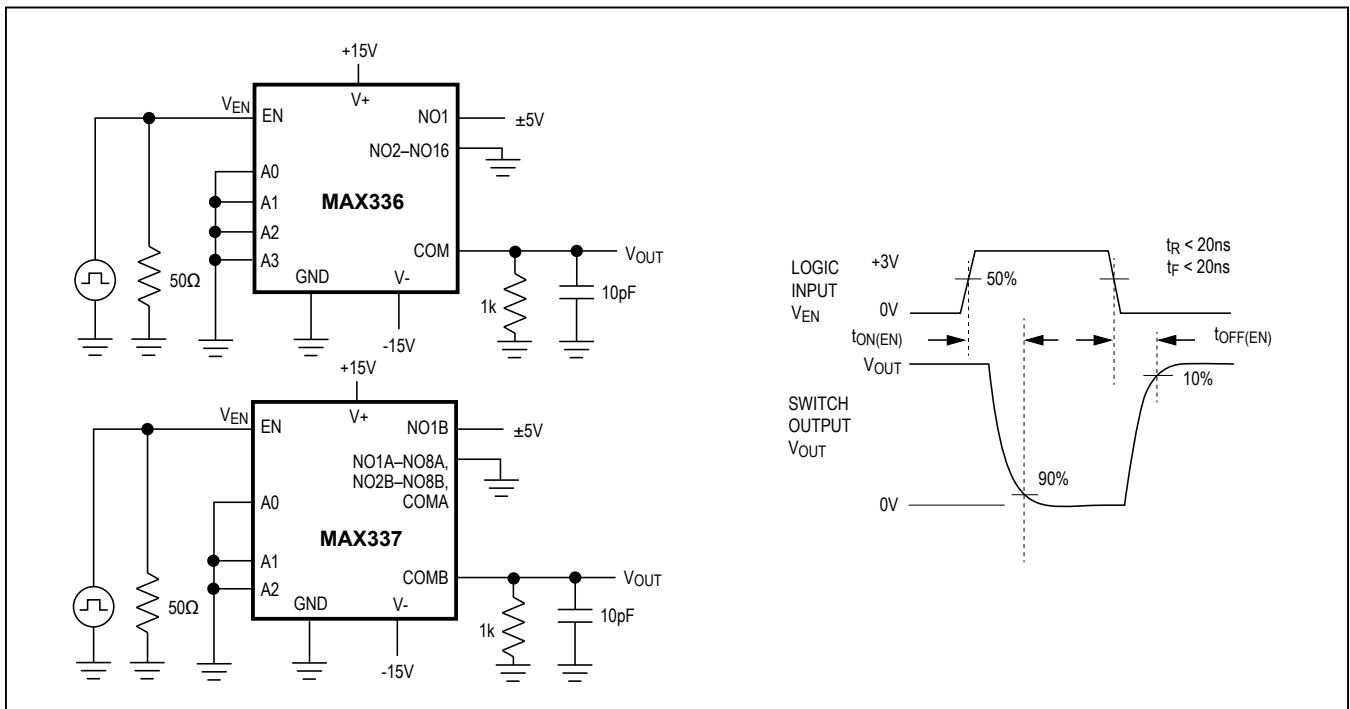


Figure 3. Enable Switching Time

Test Circuits/Timing Diagrams (continued)

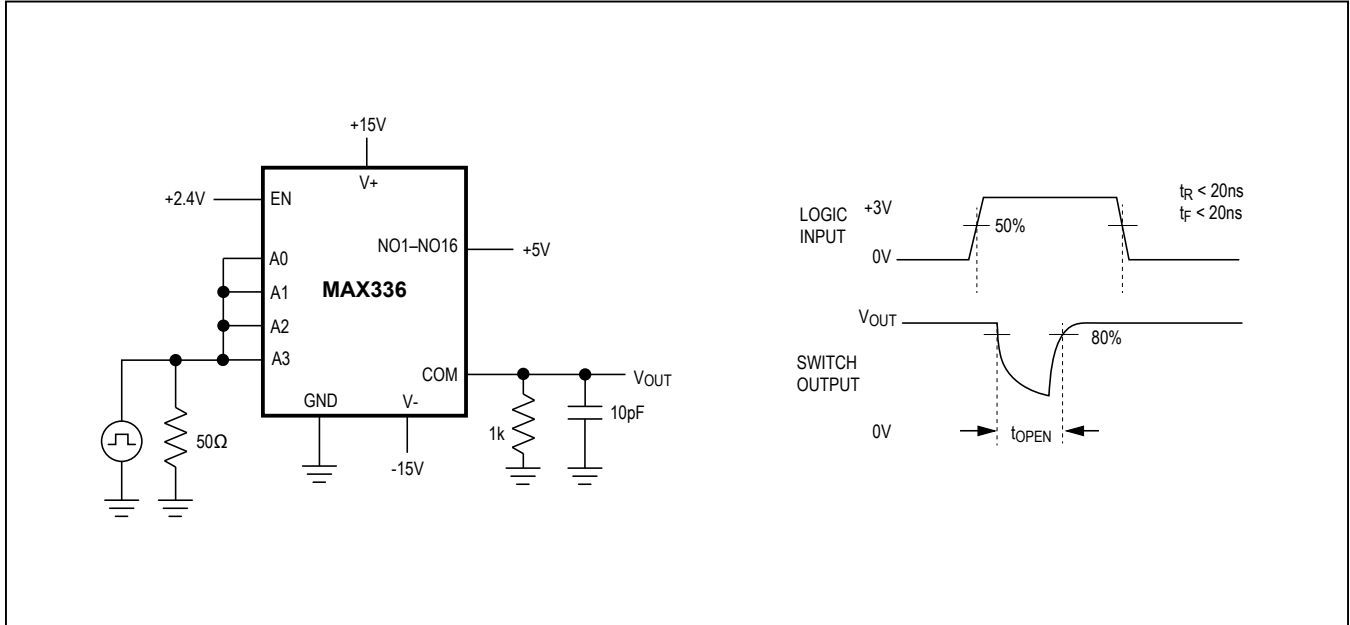


Figure 4. Break-Before-Make Interval

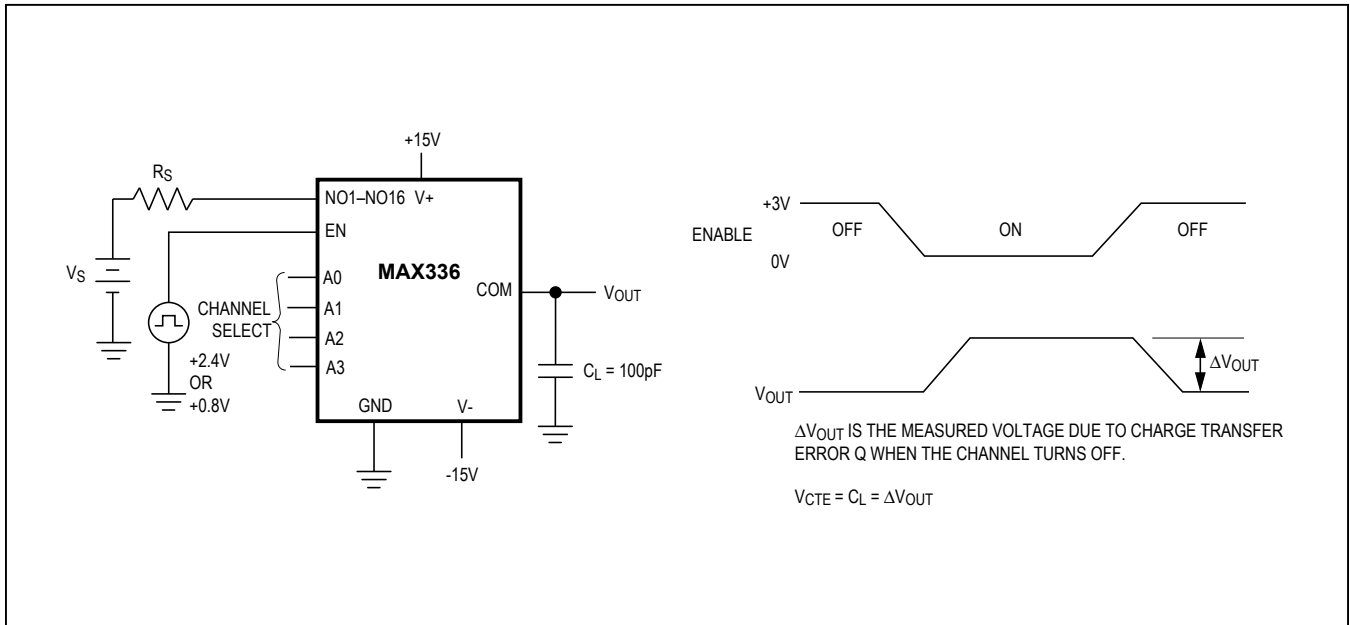


Figure 5. Charge Injection (V_{CTE})

Test Circuits/Timing Diagrams (continued)

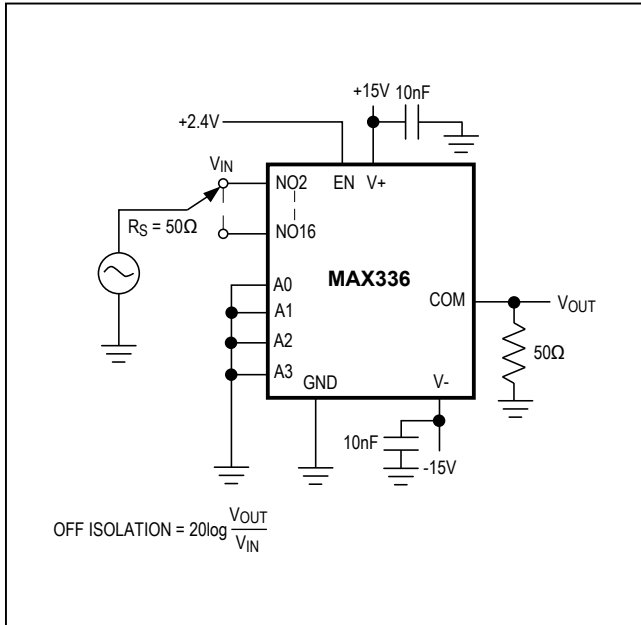


Figure 6. Off Isolation

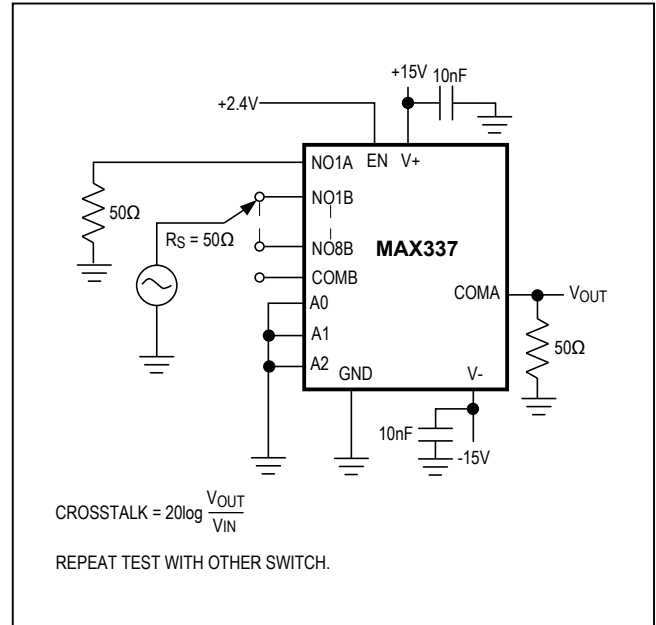


Figure 7. Crosstalk

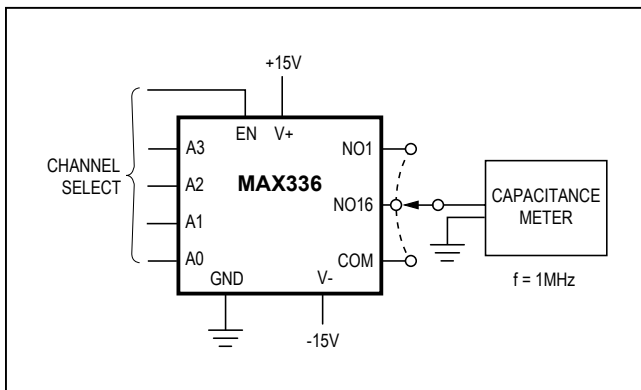


Figure 8. NO/COM Capacitance

Pin Configurations/Functional Diagrams/Truth Tables (continued)



| MAX337 | | | | |
|--------|----|----|----|-----------|
| A2 | A1 | A0 | EN | ON SWITCH |
| X | X | X | 0 | NONE |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 2 |
| 0 | 1 | 0 | 1 | 3 |
| 0 | 1 | 1 | 1 | 4 |
| 1 | 0 | 0 | 1 | 5 |
| 1 | 0 | 1 | 1 | 6 |
| 1 | 1 | 0 | 1 | 7 |
| 1 | 1 | 1 | 1 | 8 |

LOGIC "0" = $V_{AL} \leq 0.8V$, LOGIC "1" = $V_{AH} \geq 2.4V$

Ordering Information (continued)

| PART | TEMP- RANGE | PIN-PACKAGE |
|--------------------|-------------------|----------------|
| MAX336 EPI+ | -40° C to +85° C | 28 Plastic DIP |
| MAX336EWI+ | -40° C to +85° C | 28 Wide SO |
| MAX336EAI+ | -40° C to +85° C | 28 SSOP |
| MAX336EJI | -40° C to +85° C | 28 CERDIP** |
| MAX336MJI | -55° C to +125° C | 28 CERDIP** |
| MAX337 CPI+ | 0° C to +70° C | 28 Plastic DIP |
| MAX337CWI+ | 0° C to +70° C | 28 Wide SO |
| MAX337CAI+ | 0° C to +70° C | 28 SSOP |
| MAX337C/D | 0° C to +70° C | Dice* |
| MAX337EPI+ | -40° C to +85° C | 28 Plastic DIP |
| MAX337EWI+ | -40° C to +85° C | 28 Wide SO |
| MAX337EAI+ | -40° C to +85° C | 28 SSOP |
| MAX337EJI | -40° C to +85° C | 28 CERDIP** |
| MAX337MJI | -55° C to +125° C | 28 CERDIP** |

* Contact factory for dice specifications.

** Contact factory for availability.

+ Denotes lead(Pb)-free/RoHS compliant package.

Chip Information

PROCESS: BiCMOS

Package Information

For the latest package outline information and land patterns (footprints), go to www.maximintegrated.com/packages. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

| PACKAGE TYPE | PACKAGE CODE | OUTLINE NO. | LAND PATTERN NO. |
|----------------|--------------|-------------------------|-------------------------|
| 28 Plastic DIP | P28+2 | 21-0044 | — |
| 28 SSOP | A28+1 | 21-0056 | 90-0095 |
| 28 TSSOP | U28+2 | 21-0066 | 90-0171 |
| 28 WIDE SO | W28+6 | 21-0042 | 90-0109 |

Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|-----------------|---------------|---|---------------|
| 0 | 4/97 | Initial release | — |
| 1 | 10/14 | Adding MAX336CUI/EUI to Ordering Information and adding TSSOP package | 1, 2, 11, 12 |

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at www.maximintegrated.com.

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